Microcredit from Delayed Bill Payments

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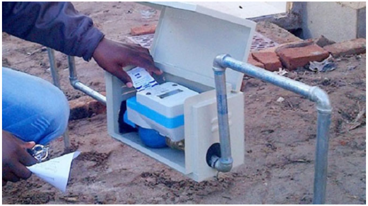
Motivation

- Households (HHs) have variable, uncertain incomes
- Smoothing consumption is costly
  - High interest rates from payday loans, credit cards, informal moneylenders, etc.
  - In Manila, only 4% have credit cards, 19% have bank accounts
- Public utilities (water, electricity, gas, etc.) may provide efficient, second-best credit by letting HHs delay their bill payments

New policies reduce delinquency

- Growing use of prepaid meters that ensure upfront payments
  - benefits → may lower prices and increase investments in quality
  - costs → no more credit from delayed bill payments

Figure: Prepaid water meter in South Africa



This Paper

- **Question** how much do HHs value delaying their bills?
  - How credit-constrained are HHs?
  - What are the welfare effects of other payment policies (ie. prepaid meters)?
- **Context** a regulated piped water utility in Manila
- **Data** monthly billing records from 2010-15 for 1.5 mil. connections
- **Approach** estimate a consumption/savings model where HHs choose when to pay their water bills

Preview of Results

- Estimated monthly interest rate is 2.2% (30% annually)
  - Globally, microfinance offers 13 to 25% annually (Cull et al. [2009])
- Willingness-to-pay for delaying bills is $\sim$70 PhP (or $1.5) per month
  - Equal to 9% of an avg water bill
- Prepaid metering (adjusting prices to cover costs) reduces welfare

Contributions to the Literature

1. Bring consumption smoothing to public utility regulation
(McRae [2015]; Szabó [2015]; Jack and Smith [2015,2016]; Szabó and Ujhelyi [2015])
2. Estimate HH consumption/savings model with utility billing data
(Deaton [1991]; Gourinchas and Parker [2002]; Laibson et al. [2007])
3. Measure credit constraints from billing delinquency
(*RCTs*: Karlan and Zinman [2009]; Giné and Karlan [2014], *Village surveys*: Townsend [1994]; Townsend and Kinnan [2012]; Ligon [1994], *Natural Experiments*: Banerjee and Duflo [2012])

Paying water bills in Manila

1. The avg HH is 85 days behind on their payments
   - Avg HH's unpaid water bills = 5% monthly HH income
2. No interest is charged on delinquent bills
3. The utility visits delinquent HHs and makes a take-it or leave-it offer: pay now or become disconnected
   - Visits are rare (4% of HH-months given >60 days delinquent)
4. To reconnect, HHs pay a small one-time fee and all unpaid bills
   - When HHs change residences, they rarely pay their outstanding bills

Data and Sample

- Data
  - Monthly billing records per connection 2010-15
    (usage, payments, and delinquency visits)
  - Merge to survey data on $\sim$50,000 connections
    (number of HHs sharing a connection and demographics for the owner)
- Sample
  - Model single HH decisions
    - Keep residential connections that serve a single HH (67%)
  - Use delinquency visits for identification
    - Keep HHs with visits (31%)
  - Drop HHs that move
    - Drop if disconnected for the last 6 months of the sample (10%)

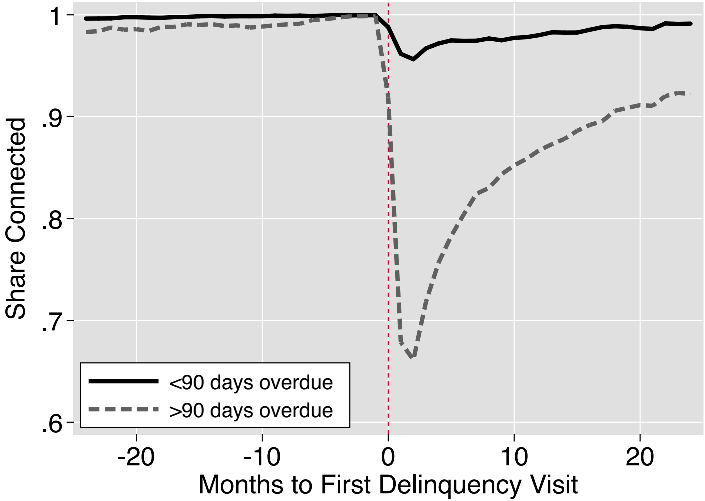
Descriptives

	Mean	SD
Usage (m3)	26.2	17.5
Bill	761	1,124
Unpaid Balance	2,416	5,070
Share of Months with Payment	0.60	0.49
Days Delinquent	84.9	155.4
Delinquency Visits per HH	1.32	0.61
Share of Months Disconnected	0.03	0.17

Total HHs: 8,260   Obs per HH: 61.8   Total Obs: 509,959

45 Philippine Peso (PhP) = 1 US Dollar
Avg monthly HH Income 31,910 PhP

Avg share connected around 1st delinquency visit



Model of HH consumption and savings

$$max \;\; E_t\Big[\sum_{\tau=t}^{\infty}(1+\delta)^{t-\tau} \; u(w_\tau, x_\tau) \; \Big]$$

$$\forall t \quad x_t + p(w_t)w_t = y_t + A_t - \frac{A_{t+1}}{1+r_a} + S_t$$

- Utility, $u(w_\tau, x_\tau) = \alpha log(w_\tau) + (1-\alpha)log(x_\tau)$ is over water, w_t, and all other goods, x_t, with discount rate, δ
- Budget constraint has water price, $p(w_t)$, and income, y_t, which takes values $(1+\theta)\bar{y}$ and $(1-\theta)\bar{y}$ with 0.5 probability
- HHs borrow and save with asset A_{t+1} where $A_{t+1} \geq -\bar{A}$ and interest rate, r_a, is equal to r_h if borrowing $(A_{t+1} \leq 0)$ and r_l else
- S_t allows for borrowing from water bills (cont.)

Borrowing from water bills, S_t

- Each period, HH faces probability π of receiving a delinquency visit
- If no visit occurs, HHs can borrow from their current bill

$$S_t = B_{t-1} - B_t$$
$$B_{t-1} - p(w_t)w_t \leq B_t \leq 0$$

  - B_{t-1} : last month's unpaid bill (≤ 0)
  - B_t : this month's unpaid bill $(= 0$ if $A_t > 0$ to prevent arbitrage$)$

- If a visit occurs, HHs can choose to disconnect $(D_t = 1)$, avoid paying their bills $(S_t = 0)$, and pay a fixed cost (f) per month for other water until they reconnect
- Otherwise, HHs pay off any unpaid bills $(S_t = B_{t-1})$ and this month's bill $(B_t = 0)$ to stay connected

Solving the model with a value function approach

$$V(X_t, z_t) = max_{x_t, w_t} \; u(x_t, w_t) + (1+\delta)^{-1} E\Big[V(X_{t+1} | z_t) \Big| z_{t+1}, T_{t,t+1} \Big]$$

$$s.t.$$

$$x_t + p(w_t) w_t = y_t + S_t$$

$$B_{t-1} - p(w_t) w_t (1 - D_t) \leq B_t \leq 0$$

$$X_t = [x_t, w_t, A_t, B_t, D_t] \quad \text{chosen by HH}$$

$$z_t = [y_t, visit_t]$$

$$T_{t,t+1} = [0.5\pi \;\; 0.5(1-\pi) \;\; 0.5\pi \;\; 0.5(1-\pi)] \times [1 \;\; 1 \;\; 1 \;\; 1]^{\mathsf{T}}$$

Calibrated Parameters

Calibrated		Source
Discount rate	$\delta = 0.015$	Structural macro literature
Savings interest rate	$r_l = 0.003$	World Bank
Visit risk	$\pi = 0.04$	Billing data
Price	$p = 20.2 + 0.2w$	Billing data
Mean inc. (PhP)	$\bar{y} = 31,910$	HH inc. survey
Borrowing limit	$\bar{A} = -32,250$	HH inc. survey (95 pctile. of loans)
Unpaid bills limit	$\bar{B} = -10,109$	Billing data (95 pctile. of unpaid bills)

All terms are monthly

Estimation with simulated method of moments

Estimated Parameters		Moments
Water preference	α	Avg usage
Income shock size	θ	Avg unpaid bills
Fixed cost of other water	f	% Disc. 1-2 months post visit
Borrowing rate from standard assets	r_h	% Disc. 1-2 months post visit given $>$90 days overdue

- Solve for the optimum of a grid of 28 asset and 28 billing values
- Compute simulated moments (avg usage, unpaid bills, etc.) with a random sequence of 10,000 states
- Choose parameters to minimize the sum of squared distances between the data and the simulated moments

Estimates

Parameters		Estimates
Water Preference	α	0.024
		(0.00075)
Income shock size	θ	0.342
		(0.0318)
Fixed cost of other water (PhP)	f	150.0
		(34.3202)
Borrowing rate from standard assets	r_h	0.022
		(0.0055)
Households		8,260
Household-Months		509,959

Standard errors in parentheses are bootstrapped at the household-level.

Counterfactuals

	(1) Current	(2) No Water Borrowing
Compensating Variation (PhP)		-69.3
Mean Usage (m3)	26.58	24.22

All values are at the household-month level.

Counterfactuals

	(1) Current	(2) No Water Borrowing	(3) No Water Borrowing and Covering Costs
Compensating Variation (PhP)		-69.3	-89.4
Mean Usage (m3)	26.58	24.22	24.18
Price Intercept (PhP/m3)	20.23		20.27
Credit supply costs (PhP)	31.3		0
Marginal cost (PhP/m3)	5		5

All values are at the household-month level.

- Credit supply costs include (1) cost of delinquency visits, (2) lost revenue from HHs that move, and (3) opportunity cost of credit

Counterfactuals

	(1) Current	(2) No Water Borrowing	(3) No Water Borrowing and Covering Costs	(4) Prepaid Metering and Covering Costs
Compensating Variation (PhP)		-69.3	-89.4	-245.5
Mean Usage (m3)	26.58	24.22	24.18	20.61
Price Intercept (PhP/m3)	20.23		20.27	27.23
Credit supply costs (PhP)	31.3		0	0
Marginal cost (PhP/m3)	5		5	5
Additional metering cost (PhP)	0		0	51

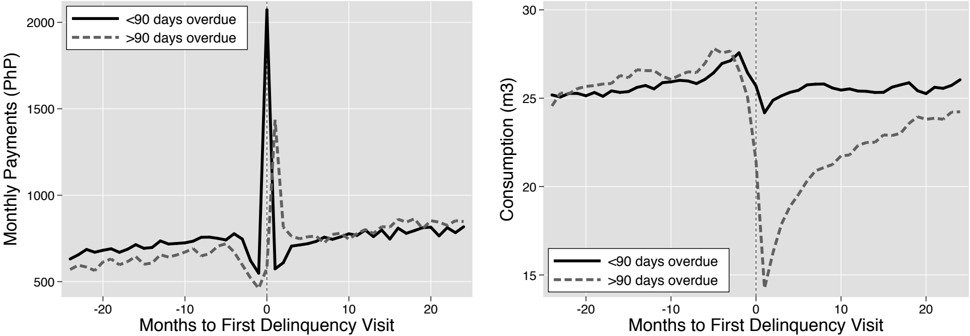
All values are at the household-month level.

Next Steps

- Estimate heterogeneity by income
- Model HHs decision to move out of Manila (and leave outstanding bills)
- Optimal delinquency visit policy for Manila

Thank you!

Other outcomes relative to 1st visit



- Avg payments only include positive payments